

PB-216 456

A STUDY OF THE OXIDATION DITCH METHOD
OF WASTE TREATMENT

West Virginia University
Morgantown, West Virginia

23 March 1966

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I

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WPD-36-01-65

A Study of the Oxidation Ditch Me

thod of Waste Treatment

Title: Demonstration Grant

Institution: Department of Civil Engineering
College of Engineering
West Virginia University
Morgantown, West Virginia 26506

Period Covered
From: Through:

Sponsor: U. S. Public Health Service

November 1, 1964 March 31, 1966

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Jerry C. Burchinal
Program Director

March 23, 1966
Date Report Prepared

Program Directors Signature: _____

II

Summary Statement

Analytical data has indicated the following:

1. The stream is still somewhat polluted, but not because of the plant operation.
2. The plant influent is diluted.
3. The treatment is exceptionally good with no odor whatsoever.
4. The effluent is of extreme clarity and good quality.

The project has been hampered by problems arising from the treatment plant initially and later, upon increased stream flow, from excessive infiltration caused by a faulty collection system. The repair of the collection system will facilitate laboratory testing. During the summer and early fall when the infiltration was at a minimum the significance of the various tests indicated an efficient operation.

Various tests are being investigated which, if successful, will allow the plant operators to evaluate the efficiency of the treatment readily. The principle is that of correlating a simple gas collection to extensive solid test information.

A more complete set of nitrogen tests correlated with different plant conditions will determine the nitrate production and possible control.

More work on the velocity and oxygen uptake should prove the economy of this method of aeration and also its flexibility.

The significant ABS (alkyl-benzene sulfonate) reduction will be further investigated to determine the effect of the new soft detergents.

III

(a)

Concise Statement of Progress

Activities and Accomplishments

Since the ditch was put into continuous operation, influent and effluent samples have been collected for relatively complete laboratory analysis. The sampling is done generally twice weekly in addition to daily sampling and testing by the plant operator. Samples are composited over a six hour period normally although some effluent samples were composited over a twenty four hour period.

It became apparent from the initial tests that the actual plant flow exceeded the design flow. Since the system is basically a combined system the flows were assumed to be erratic and high at times of rain, but the flows were found to remain high several days after the rain occurred. During periods of no rain the sewage flow was found to be two to three times the water supplied to the city which averages 73,000 GPD. The flow values are recorded continually and the meter is volumetrically checked to determine the accuracy. The sewage and sludge pumps ratings are also checked periodically to determine whether they are operating properly. This method of flow investigation has detected valves partially clogged and faulty motor armatures which were replaced.

After a short period of chemical testing of the influent it became apparent that the sewage was relatively dilute. The BOD was consistently under 100 ppm and at times as low as 20 ppm. The pH was always over 7.0, the DO was consistently near saturation and at one time found to super-saturated at 11.5 ppm. The temperature was found to fluctuate abnormally.

The stream testing consists of weekly sampling at five locations; above town, in town, directly above the plant, directly below the plant, and two miles below the plant. The initial chemical, bacteriological, and biological testing indicated existing pollution which increased throughout the length of the stream.

treatment plant. A stream BOD as high as 50 ppm at a time of low stream flow, ABS over 1.0, and DO values as low as 4.0 all indicated pollution. The presence of excessive numbers of pypa snails, tubifex worms, as well as abnormal algal growths were also discovered. The coliform counts on E. Coli, Enterococcus, and Fecal were all in the range indicating pollution.

With the sewage abnormally weak and the stream polluted it was decided to check the stream closely to try to discover the trouble. An investigation resulted in finding three broken connections, one manhole destroyed and never repaired or replaced, and several pipes that had never been connected, (Photographs 17-20).

Three traps located in manholes near the center of town need constant cleaning as they were subject to clogging thereby allowing raw sewage to enter the stream. (Photographs 21-23). There are at least two places where the pipe is probably broken underground as the stream can be seen flowing into the ground in the vicinity of the sewer and dye tests have confirmed infiltration at these places.

The above faults have all been reported to the engineer and it is hoped that with the better weather coming the repairs will be made promptly.

The chemical testing of plant samples has yielded results which are very significant. In addition to the tests previously mentioned the following results have been obtained:

1. Influent BOD (20-100 ppm) reduced to 0.8 to 7 mg/l
2. SVI (sludge volume index) 50 to 122, average of 80
3. Sludge Age 6.3 to 12.9 days, average 10 days
4. Mixed liquor settleable solid 150 to 400 ml/l, average 220 ml/l
5. Mixed liquor total solids 2400 to 4100 mg/l, average 3200 mg/l
6. ABS reduction 50 to 85%
7. Specific conductance 7 to 17 gpg, average 10.0

8. pH relatively constant at 7.1 average
9. Ammonia Nitrogen reductions from 30 to 0 mg/l
10. Nitrite reduction from to 0 mg/l
11. Phosphate generally unchanged, average 15 mg/l
12. Chloride range 15 to 84 mg/l influent, average 40 mg/l
13. Alkalinity 145 to 184, average 130 mg/l
14. Sulfates average 60 mg/l

Since the plant has been operating continuously there have not been any noticeable odors and the floc's general condition has seemed to improve. With the warmer weather the plants flexibility is going to be checked through alternation of the ditch surface level and subsequent rotor immersion. With the relatively high DO content in the effluent shutoff periods and alternating periods of the rotors will be investigated. With the relatively large radius at the bends the flow characteristics seem to be excellent with a minimum of energy lost. Oxygen uptake under the different plant operating conditions is to be investigated in addition to the chemical tests.

(b)

The Cameron Oxidation Ditch Operational History

In January 1965, the initial filling of the ditch occurred and immediately the ditch liner began to lift at several sections. Along the north side of the ditch there was extensive caving in of the sloped side. The plant was out of operation for over five months in order to repair the damage for which the city was billed \$4,000.00.

The plant was again put into operation the first week of June and again the ditch liner lifted in the region just before the south rotor. The plant was reportedly accepted by the sanitary board at this time prior to the repair of the lifted liner. The plant was kept in operation at this time by placing stone in the ditch in the hope of holding the liner down. Trouble started with the sewage pumps and the sludge return system soon after the start of the operation. The sewage pumps would stop due to overheating and would have to be put back into operation by starting them manually. The sludge return system was subject to clogging until proper settings were established. The sludge return line between the manhole and the ditch clogged sufficiently to require emptying of the ditch in order to unclog it. While the ditch was out of operation it was decided by the city to plaster the side where the ditch liner had become loose. The repair was made using a mortar cement mix with mesh wire reinforcing. (Photographs 1-6).

Upon refilling the ditch fourteen more sheets of the ditch liner started to lift in the region just before the north rotor. The sewage pumps continued to operate erratically. The flow meter was suspected to be recording incorrectly. The plant was kept in operation until a rain of approximately 4" overnight caused extensive damage. Most of the damage was on the north side of the ditch which did not have adequate drainage. Lining was torn loose and much debris was carried into the ditch. (Photographs 7-17).

The engineer was informed of the damage and after two weeks of inaction the city decided to repair the plant on their own. The loose liner was removed from the sides and the slope was repaired as before.

The sludge lines before and after the manhole required extensive work to free them of debris. The sludge pump had to be cleaned and repacked as it was clogged with debris.

The ditch was again refilled only to be emptied shortly thereafter due to additional lifting of the liner which had been caused by air getting underneath while the ditch had been emptied. At this time the city decided to place concrete on the bottom just prior to the south rotor. It took 9 cu. yds. of concrete to insure that the bottom would remain intact.

The plant was again filled August 26th, with the sewage pumps breaking down the following day due to flow fluctuations caused by rain resulting in overheating of the pump motors. The engineer after two months of trouble with the pumps had the armatures replaced on September 7th.

On September 15th the lift station was put on one pump operation by the engineer as the influent appeared to be too much for the plant even though the plant pumps had been repaired. On September 18th the pumps started to operate erratically and the engineer suggested that the city hire someone to check them. The plastic bag for the control system, which is located in a turbulent flow region of the sump was found to be broken. The bag was replaced September 27th.

Throughout the first three weeks of October the plant operated fairly well except for occasional power failures which would cause the plant equipment to stop and require manual starting. On October 21st a representative from the flowmeter company checked the calibration of the meter. He decided that the meter had never operated satisfactorily as it had not been installed correctly. He further suggested that the meter be converted to a larger magnitude calibration as the actual plant flow was greater

than the design flow. The plastic bag of the pump control system again was replaced October 25th. The chlorine water pump was replaced October 26th as it had been making much noise. The sewage pump valves were cleaned and adjusted as the pumping rate was lower than expected. The lift station was put into full operation (October 26th).

During the month of November everything operated well. On November 10th the engineer suggested putting the lift station back to one pump operation. This would have diverted raw sewage to the stream bed and no dilution was available. As there was no stream flow at that time

December rains increased the flow of the stream and the plant flow increased correspondingly. The excessive infiltration returned in one pump operation of the lift station and the diversion of about one half of the total sewage flow to the stream. The engineer repeatedly blamed the high flows of the total sewage flow to the stream. The flood two mains, that run through the main section of town, for the infiltration. The flow from these lines was diverted to the stream and no significant decrease was noticed.

In January the cold weather and snow had hit the plant. During a week of prolonged cold weather with little effect on the overall treatment. Several days below zero a shell of ice formed over the rotors without stopping them. The infiltration remained excessive resulting in BOD values of the influent of 20. The sanitary board compiled a checklist of known system faults at the request of the engineer. The sanitary board is suggesting withholding of the final payment until all the terms in the specifications are satisfied in their estimation.

In February there was no work done to improve the system. The melting snow resulted in very high stream flows. The streamer in the water line to the chlorinator clogged every few days. A representative from the pump company said the system was

improperly designed and this had been the reason for the pump replacement earlier. The south rotor broke down due to excessive bearing wear and the bearings were replaced. It was decided by the city to overhaul the north rotor after the south rotor was put back into service. The out of service time of three days did not have any apparent effect on the efficiency of the plant. The BOD removal, solids removal, and dissolved oxygen level remained essentially the same.

During February, the sludge level in the clarifier was nearing the surface and it became apparent that more sludge had to be returned to the ditch. It was suggested by the investigators that a timer should be installed to automatically start the sludge return pumps. A timer was installed that starts the pump four times a day and has it run for a fifteen minute period. This has resulted in a lower sludge surface level and has minimized the possibility of clogging of the sludge return lines. The warmer weather at the end of February resulted in an extremely clear effluent.

Most of the troubles encountered to date have resulted from improper action by the authorities concerned:

1. The engineer had been a member of an inactive city sanitary board.
2. The sanitary board reportedly accepted the plant without council consent.
3. The right of way for the sewers was not made in the allotted time.
4. The sanitary board did not appoint an inspector other than the engineer's.
5. The sanitary board did not have any meetings until they were instructed to do so by the city council at a July 20, 1965 meeting.
6. The engineer did not inform the city of any troubles or faults.
7. There has not been any maintenance equipment purchased by the city.
8. The state health department has been inactive in handling complaints from the city residents.

(c)

Project Director - Jerry C. Burchinal, Professor

Period of Employment - November 1, 1964 to March 31, 1966

Per cent of time devoted to project - 12.5

Project Co-Director - Charles R. Jenkins, Associate Professor

Period of Employment - November 1, 1964 to March 31, 1966

Per cent of time devoted to project - 12.5

Project Engineers

William L. Zemaitis - Graduate Student

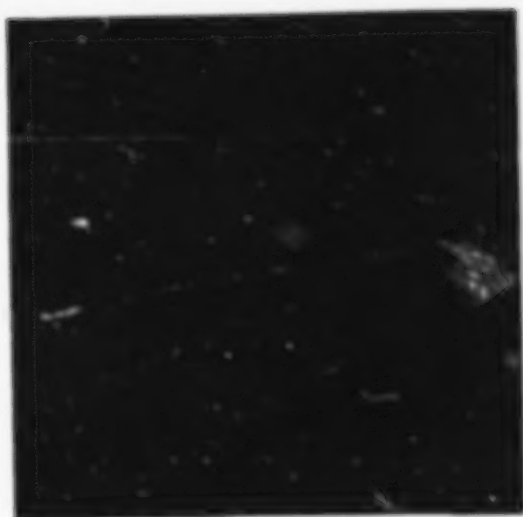
Period of Employment - June 1, 1965 to March 31, 1966

Per cent of time devoted to project - 50

Hsueh I. Shih, Graduate Student

Period of Employment - September 1, 1965 to March 31, 1966

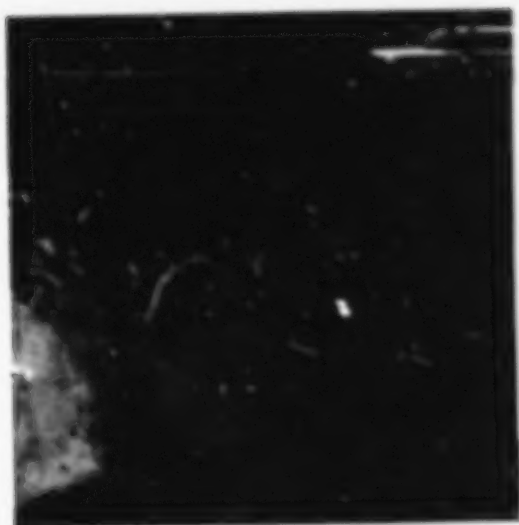
Per cent of time devoted to project - 50



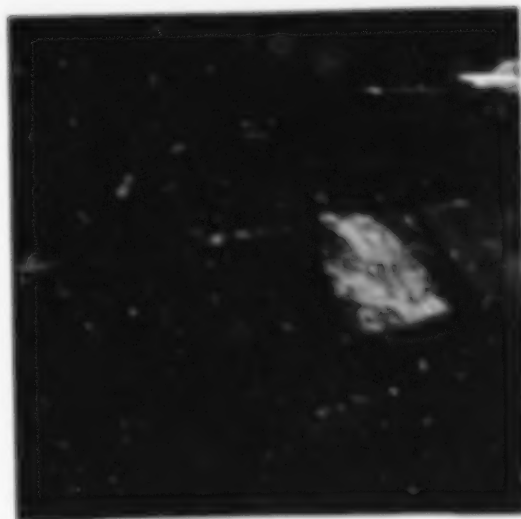
Photograph 1



Photograph 2



Photograph 3



Photograph 4

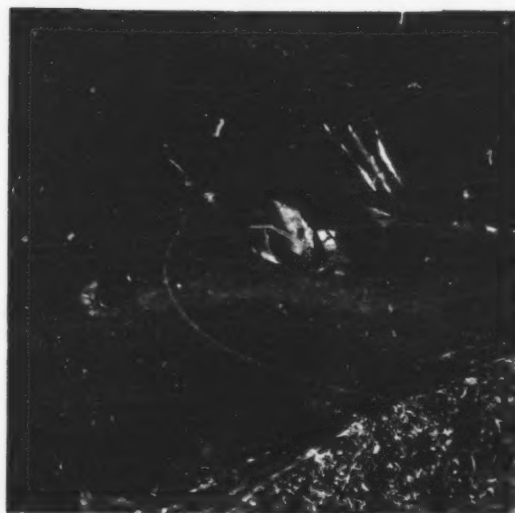
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Photograph 5



Photograph 6



Photograph 7



Photograph 8



Photograph 9



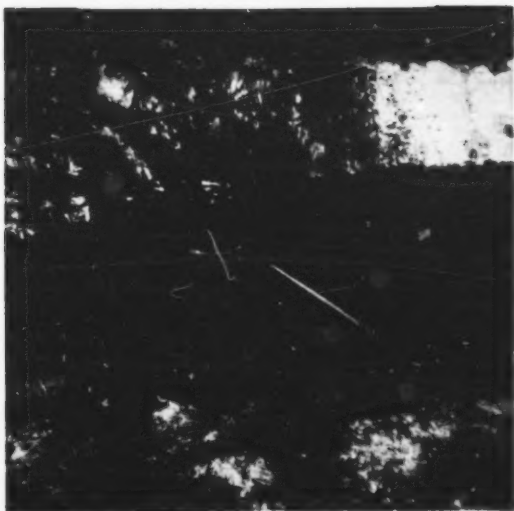
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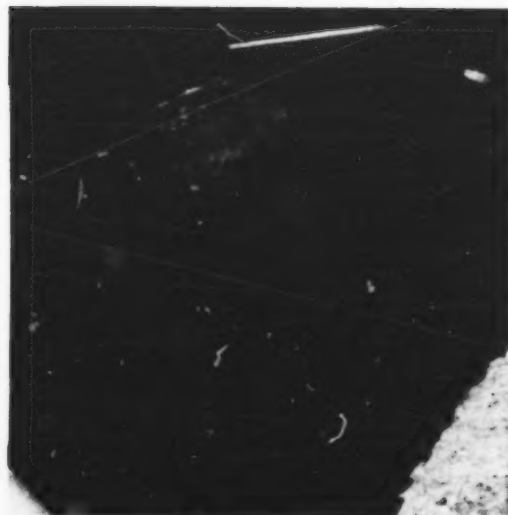
Photograph 11



Photograph 12



Photograph 13



Photograph 14



Photograph 15



Photograph 16





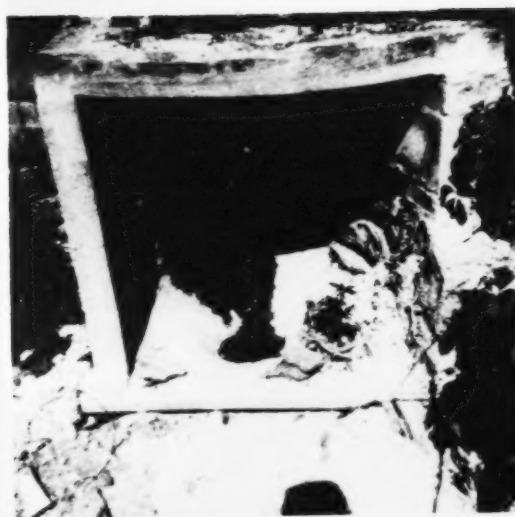
Photograph 17



Photograph 18



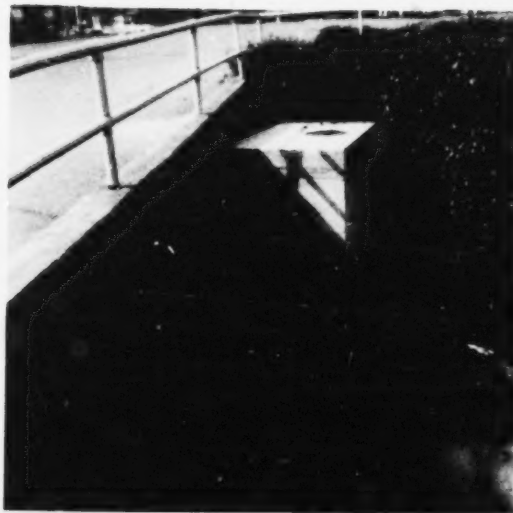
Photograph 19



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Photograph 20



Photograph 21



Photograph 22

21

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